General

Guideline Title

ACR Appropriateness Criteria® imaging after total hip arthroplasty.

Bibliographic Source(s)

Weissman BN, Palestro CJ, Appel M, Baccei SJ, Bencardino JT, Fries IB, Hochman MG, Jacobson JA, Mintz DN, Mlady GW, Murphey MD, Newman JS, Rosenberg ZS, Rubin DA, Small KM, Expert Panel on Musculoskeletal Imaging. ACR Appropriateness CriteriaÂ® imaging after total hip arthroplasty. Reston (VA): American College of Radiology (ACR); 2015. 24 p. [168 references]

Guideline Status

This is the current release of the guideline.

This guideline updates a previous version: Weissman BN, Dalinka MK, Alazraki N, Daffner RH, DeSmet AA, El-Khoury GY, Kneeland JB, Manaster BJ, Pavlov H, Rubin DA, Steinbach LS, Haralson RH III, Expert Panel on Musculoskeletal Imaging. Imaging after total hip arthroplasty (THA). [online publication]. Reston (VA): American College of Radiology (ACR); 2005. 8 p. [51 references]

This guideline meets NGC's 2013 (revised) inclusion criteria.

Recommendations

Major Recommendations

ACR Appropriateness Criteria®

Clinical Condition: Imaging after Total Hip Arthroplasty

Variant 1: Follow-up of the asymptomatic patient with a total hip arthroplasty.

Radiologic Procedure	Rating	Comments	RRL*
X-ray hip	9		
CT hip without contrast	4	This procedure can be considered in late follow-up.	

Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

*Relative Radiation Level

Radiologic Procedure	Rating	Comments	RRL*
CT hip with contrast	1		
CT hip without and with contrast	1		
MRI hip without contrast	1		O
MRI hip without and with contrast	1		O
Tc-99m bone scan hip	1		
US hip	1	This procedure can be used as a screening test for metal-on-metal prostheses.	O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 2: Total hip arthroplasty, evaluating suspected component malposition.

Radiologic Procedure	Rating	Comments	RRL*
X-ray hip	9		
CT hip without contrast	6		
Fluoroscopy hip	4		Varies
CT hip with contrast	1		
CT hip without and with contrast	1		
MRI hip without contrast	1		O
MRI hip without and with contrast	1		O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 3: Evaluating patients with a painful primary total hip arthroplasty: infection not excluded.

Radiologic Procedure	Rating	Comments	RRL*
X-ray hip	9	This procedure is complementary to other studies.	
Aspiration hip	9	This procedure is the best test for excluding infection.	Varies
Aspiration and arthrography hip	6		Varies
CT hip with contrast	5		
MRI hip without and with contrast	5		O
In-111 WBC and Tc-99m sulfur colloid scan hip	5	This procedure is often considered the best imaging test for infection.	
CT hip without contrast	4		
MRI hip without contrast	4		O
Tc-99m bone scan hip	4		
Tc-99m bone scan and Ga-67 scan hip	4		
FDG-PET hip	4		
F-18 fluoride PET hip	3		
US hip	3		O
CT hip without and with contrast	1		
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 4: Evaluating patients with a painful primary total hip arthroplasty: suspect aseptic loosening (infection excluded).

Radiologic Procedure	Rating	Comments	RRL*

Radiologic Procedure	Rating	Comments	RRL*
CT hip without contrast	5		
Tc-99m bone scan hip	5		
X-ray arthrography hip	5		
Tc-99m nuclear arthrography hip	4		
FDG-PET hip	3		
F-18 fluoride PET hip	3		
Image-guided anesthetic injection of hip	3	A positive study usually indicates an articular cause for pain.	Varies
MRI hip without contrast	3		O
CT hip with contrast	1		
CT hip without and with contrast	1		
MRI hip without and with contrast	1		O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 5: Evaluating suspected particle disease (aggressive granulomatous disease, infection excluded).

Radiologic Procedure	Rating	Comments	RRL*
X-ray hip	9	This procedure is complementary to other studies.	
CT hip without contrast	8	This procedure is an alternative to MRI.	

Radiologic Procedure	Rating	Comments	RRL*
MRI hip without contrast	7	This procedure is an alternative to CT.	O
MRI hip without and with contrast	5	This procedure may be appropriate but there was disagreement among panel members on the appropriateness rating as defined by the panel's median rating.	O
Tc-99m bone scan hip	3		
CT hip with contrast	1		
CT hip without and with contrast	1		
FDG-PET hip	1	Very limited data is available.	
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 6: Evaluating patients with a painful primary metal-on-metal total hip arthroplasty or surface replacement: evaluate for aseptic lymphocyte-dominated vasculitis-associated lesion.

Radiologic Procedure	Rating	Comments	RRL*
MRI hip without contrast	8		O
US hip	6		O
X-ray hip	5	This procedure may be appropriate but there was disagreement among panel members on the appropriateness rating as defined by the panel's median rating.	
MRI hip without and with contrast	5	Gadolinium contrast is usually not needed but may define areas of necrosis.	O
Aspiration hip	5	This procedure can detect metallosis.	Varies
CT hip without contrast	3		
CT hip with contrast	3		
CT hip without and with contrast	1		

Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			
Radiologic Procedure	Rating	Comments	RRL*
			*Relative Radiation Level

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 7: Total hip arthroplasty, trochanteric pain; suspect abductor injury or trochanteric bursitis.

Radiologic Procedure	Rating	Comments	RRL*
X-ray hip	9	This procedure is complementary to other studies.	
MRI hip without contrast	8	This procedure is an alternative to US.	O
US hip	7	This procedure is an alternative to MRI.	O
CT hip without contrast	3		
X-ray arthrography hip	3		
MRI hip without and with contrast	2		O
CT hip with contrast	1		
CT hip without and with contrast	1		
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 8: Total hip arthroplasty; suspect iliopsoas bursitis or tendinitis.

Radiologic Procedure	Rating	Comments	RRL*
X-ray hip	9	This procedure is complementary to other studies.	
MRI hip without contrast	8	This procedure is an alternative to US.	O
US hip	8	This procedure is an alternative to MRI.	O
Injection anesthetic iliopsoas tendon	6		Varies
CT hip without contrast	4	This procedure is useful to assess component position.	
CT hip with contrast	4		
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation

Radiologic Procedure	Rating	Comments	RRL*
CT hip without and with contrast	1		
MRI hip without and with contrast	1		O
X-ray arthrography hip	1		
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 9: Total hip arthroplasty, suspect nerve damage.

Radiologic Procedure	Rating	Comments	RRL*
MRI hip without contrast	9	MR neurography protocols may be used.	O
X-ray hip	5	This procedure may be appropriate but there was disagreement among panel members on the appropriateness rating as defined by the panel's median rating.	
US hip	4		O
CT hip without contrast	2		
MRI hip without and with contrast	2		O
CT hip with contrast	1		
CT hip without and with contrast	1		
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 10: Total hip arthroplasty, evaluate heterotopic bone.

Radiologic Procedure	Rating	Comments	RRL*
X-ray hip	9		
CT hip without contrast	7	This procedure is complementary to radiography when	*Relative
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			

Radiologic Procedure	Rating	Comments	RRL*
		additional detail is needed.	
Tc-99m bone scan hip	5	The panel noted this procedure is not often currently used for evaluating heterotopic bone.	
MRI hip without contrast	5	This procedure may be appropriate but there was disagreement among panel members on the appropriateness rating as defined by the panel's median rating. Neurovascular structures may be delineated.	O
US hip	4		O
CT hip with contrast	1		
CT hip without and with contrast	1		
MRI hip without and with contrast	1		O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 11: Total hip arthroplasty, suspect periprosthetic fracture.

Radiologic Procedure	Rating	Comments	RRL*
X-ray hip	9		
CT hip without contrast	8	This procedure is complementary to radiography for more detail or if radiograph is negative.	
Tc-99m bone scan hip	5	This is no longer a primary imaging test, but this procedure can be useful when cross-sectional imaging is negative.	
MRI hip without contrast	5	This procedure may be appropriate but there was disagreement among panel members on the appropriateness rating as defined by the panel's median rating.	O
CT hip with contrast	1		
CT hip without and with contrast	1		
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Radiologic Procedure	Rating	Comments	RRL*
MRI hip without and with contrast	1		O
US hip	1		O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Summary of Literature Review

Introduction/Background

The number of primary total hip arthroplasties performed in the United States was 220,000 in 2003 and this number is expected to rise to 572,000 by 2030. Results are often long lasting, with approximately 87% survival after 10 years. Revisions are most often due to instability/dislocation, mechanical loosening, or infection. Metal-on-metal prostheses can be associated with additional complications, including tissue hypersensitivity reaction.

Patients with loosening or infection usually (but not always) have pain, whereas those with particle disease and resulting osteolysis or with metal hypersensitivity can be asymptomatic. Pain patterns can suggest the correct diagnosis, but complications can be difficult to identify clinically. Therefore, understanding the use of imaging is of particular importance.

All symptomatic patients should undergo radiography. Availability of old radiographs to compare to new ones facilitates the diagnosis of subtle changes such as can occur in loosening, particle disease, or infection.

Overview of Imaging Techniques

Radiography

Radiography is the standard first examination for evaluating total hip arthroplasties. Radiographs are used clinically to evaluate component position and wear. Radiographic features of loosening can be present even if symptoms are absent. Prior to revision surgery, standard views and additional views (such as the Lowenstein lateral view or oblique views) can be helpful.

Arthrography

Fluoroscopy, computed tomography (CT), or ultrasound (US) can be used for needle placement. Contrast instilled into the joint can detect sinus tracts, and fistulae and collections that connect to the joint and can help evaluate component loosening. Fluid sampling can be done at the time of arthrography.

Computed Tomography

Imaging with a metal prosthesis (or especially with bilateral metal prostheses) in place using older scanners and techniques resulted in significant image degradation due to artifacts. Newer equipment and imaging protocols, however, have decreased artifact and can aid in assessment of the bone, cement, and soft tissues around metal components. Osteolysis, implant position, hardware integrity, wear, fractures, heterotopic ossification, hematomas, and fluid collections can be assessed. Dual-energy CT can reduce artifacts due to metal prostheses and reduce the radiation dose.

Quantitative CT

Quantitative CT allows the remodeling of trabecular and cortical bone near an acetabular or femoral component to be assessed. However, this remains largely a research tool.

Magnetic Resonance Imaging (MRI)

Improvements in MRI techniques have enabled useful information to be obtained even around total hip replacements. Structures such as the joint capsule, intra-articular content, muscles, nerves, vessels, and tendons can be evaluated.

Dual-energy X-ray Absorptiometry

This technique has been used to measure changes in bone density around femoral and acetabular components. Bone density changes associated

with various component designs can be studied. However, dual-energy x-ray absorptiometry scanning after total hip arthroplasty (THA) remains largely a research tool.

Bone Scan

Bone scans are sensitive indicators of a failed arthroplasty but are not able to reliably indicate the cause of failure. Thus, the absence of increased uptake on the bone scan is thought to be strong evidence against a prosthetic complication such as loosening or infection.

Gallium Scan

Gallium-67 citrate accumulates not only in areas of infection but also in areas of new bone formation and in aseptic inflammation. Therefore, gallium scans are usually compared to bone scans to identify areas of disproportionately increased or geographically disparate activity on the 2 scans.

Labeled Leukocyte (Whole Blood Cell [WBC]) and WBC/Technetium (Tc)-99m Sulfur Colloid Bone Marrow Scanning

Leukocytes, labeled or unlabeled, accumulate in a number of infectious processes, including acute osteomyelitis, acute exacerbations of chronic osteomyelitis, septic arthritis, and abscesses. Leukocytes also accumulate in bone marrow, the normal distribution of which can be variable. "Orthopedic hardware, fractures, neuropathic joints, and heterotopic bone alter the 'normal' distribution of marrow, making it difficult to differentiate labeled leukocyte uptake in unusually located, but otherwise normal, marrow from uptake in infection." Combining marrow scans with WBC scans can help distinguish WBC uptake due to variations in marrow distribution from uptake due to infection. Both radiopharmaceuticals accumulate in bone marrow but only WBCs accumulate in infection. The addition of marrow imaging to WBC scanning has improved accuracy (primarily by decreasing false-positive results) to about 90%, but false-negative cases (decreased sensitivity) can occur.

Nuclear Arthrography

Intra-articular injection of radiopharmaceuticals was first used for evaluation of femoral component loosening, but later procedural changes allowed both acetabular and femoral components to be evaluated. When performed simultaneously with bone scanning, the nuclear arthrography component of the examination is performed with various indium-111 complexes. These complexes, however, are not approved for use in the United States.

Fluorine-18-fluoro-deoxyglucose (FDG) Positron Emission Tomography (PET)

Increased uptake of FDG reflects increased glucose metabolism. Increased uptake is seen in infected prostheses as well as in the setting of aggressive granulomatous disease due to increased energy demand. Overall accuracy for detecting these complications is 89%. FDG-PET requires only 1 injection and results are available within 4 hours, but the test is not universally available and is more expensive than the 3-phase bone scan.

^{18}F-fluoride Sodium Fluoride (^{18}F-fluoride)

An exquisitely sensitive bone-seeking PET radiopharmaceutical used to identify skeletal abnormalities. Uptake of ^{18}F-fluoride depends on blood flow and bone remodeling, similar to the uptake mechanism of Tc-99m-MDP, but with superior pharmacokinetic characteristics, including faster blood clearance and twofold higher uptake in bone. Nearly all causes of increased new bone formation produce increased ^{18}F-fluoride uptake. ^{18}F-fluoride uptake can be quantified by calculating the standardized uptake value (SUV). Data on ^{18}F-fluoride-PET imaging of hip arthroplasties are limited. Potential uses include diagnosing avascular necrosis following hip resurfacing arthroplasty, analyzing metabolic bone responses to prosthetic implants to obtain information about implant stability, and differentiating the aseptically loosened from the infected prosthesis.

US

This technique is useful for imaging soft tissues around a hip prosthesis, including effusion, collections, synovial thickening, tissue hyperemia, tendons, and bursae. The "normal" sonographic appearances after THA have been described. US can also be used to guide joint aspiration or synovial biopsy.

This review presents information on the usefulness of various imaging procedures in patients with THA for surveillance and for the assessment of certain complications.

See the original guideline document for a discussion of the imaging modalities by variant.

Summary of Recommendations

- A large number of techniques are available for evaluating total hip arthroplasties.
- Radiographs remain the standard imaging modality.

- Bone scan is a useful screening modality.
- Joint aspiration is the best available test for evaluation of joint infection.
- WBC/marrow scan is overall the best imaging test for diagnosing infection.
- CT and MRI are useful for assessing granulomatous disease. Radiography underestimates bone loss.
- MRI appears to be the best technique for evaluating complications of metal-on-metal prostheses such as aseptic lymphocyte-dominated vasculitis-associated lesion (ALVAL). US has been used for screening but appears to be less sensitive than MRI.
- MRI or US is useful for assessing abductor tendon and muscle abnormalities.
- Anesthetic/corticosteroid injection can help confirm the diagnosis of iliopsoas impingement and alleviate symptoms.
- MRI is the most effective method for evaluating nerve damage after THA.
- Heterotopic ossification is usually evaluated on radiographs, although bone scan and possibly US may be more sensitive for early diagnosis.
- Most periprosthetic fractures can be diagnosed on radiographs.

Abbreviations

- CT, computed tomography
- FDG-PET, fluorine-18-fluoro-deoxyglucose positron emission tomography
- Ga, gallium
- In, indium
- MRI, magnetic resonance imaging
- Tc, technetium
- US, ultrasound
- WBC, white blood cell

Relative Radiation Level Designations

Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
O	0 mSv	0 mSv
	<0.1 mSv	<0.03 mSv
	0.1-1 mSv	0.03-0.3 mSv
	1-10 mSv	0.3-3 mSv
	10-30 mSv	3-10 mSv
	30-100 mSv	10-30 mSv
*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (e.g., region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies."		

Clinical Algorithm(s)

Algorithms were not developed from criteria guidelines.

Scope

Disease/Condition(s)

- Total hip arthroplasty (THA)
- Complications after THA

Guideline Category

Diagnosis

Evaluation

Clinical Specialty

Geriatrics

Internal Medicine

Orthopedic Surgery

Physical Medicine and Rehabilitation

Radiology

Intended Users

Advanced Practice Nurses

Health Plans

Hospitals

Managed Care Organizations

Physician Assistants

Physicians

Students

Utilization Management

Guideline Objective(s)

To evaluate the appropriateness of radiologic procedures for imaging after total hip arthroplasty (THA)

Target Population

Patients who have had total hip arthroplasty (THA)

Interventions and Practices Considered

1. X-ray, hip
2. X-ray arthrography, hip
3. Computed tomography (CT), hip
    - Without contrast
    - With contrast
    - Without and with contrast
4. Magnetic resonance imaging (MRI), hip
    - Without contrast
    - Without and with contrast
5. Technetium (Tc)-99m bone scan, hip

6. Tc-99m nuclear arthrography, hip
7. Ultrasound (US), hip
8. Fluoroscopy, hip
9. Aspiration, hip
10. Aspiration and arthrography, hip
11. Indium (In)-111 white blood cell (WBC) and Tc-99m sulfur colloid scan, hip
12. Tc-99m bone scan and gallium (Ga)-67 scan, hip
13. Fluorine-18-fluoro-deoxyglucose (FDG) positron emission tomography (PET), hip
14. Image-guided anesthetic injection, hip
15. ^{18}F-fluoride sodium fluoride (18F-fluoride) PET, hip
16. Anesthetic injection, iliopsoas tendon

Major Outcomes Considered

- Utility and reliability of radiologic procedures in follow-up evaluation after total hip arthroplasty (THA)
- Sensitivity, specificity, positive/negative predictive values, and diagnostic accuracy of radiologic procedures

Methodology

Methods Used to Collect/Select the Evidence

Hand-searches of Published Literature (Primary Sources)

Hand-searches of Published Literature (Secondary Sources)

Searches of Electronic Databases

Description of Methods Used to Collect/Select the Evidence

Literature Search Summary

Of the 51 citations in the original bibliography, 21 were retained in the final document. Articles were removed from the original bibliography if they were more than 10 years old and did not contribute to the evidence or they were no longer cited in the revised narrative text.

A new literature search was conducted in July 2008 and updated in May 2015 to identify additional evidence published since the *ACR Appropriateness Criteria® Imaging After Total Hip Arthroplasty* topic was finalized. Using the search strategies described in the literature search companion (see the "Availability of Companion Documents" field), 879 articles were found. Nine articles were added to the bibliography. Eight hundred seventy articles were not used due to either poor study design, the articles were not relevant or generalizable to the topic, the results were unclear, misinterpreted, or biased, or the articles were already cited in the original bibliography.

The author added 138 citations from bibliographies, Web sites, or books that were not found in the new literature search.

Number of Source Documents

Of the 51 citations in the original bibliography, 21 were retained in the final document. The new literature search conducted in July 2008 and updated in May 2015 identified 9 articles that were added to the bibliography. The author added 138 citations from bibliographies, Web sites, or books that were not found in the new literature search.

Methods Used to Assess the Quality and Strength of the Evidence

Weighting According to a Rating Scheme (Scheme Given)

Rating Scheme for the Strength of the Evidence

Definitions of Study Quality Categories

Category 1 - The study is well-designed and accounts for common biases.

Category 2 - The study is moderately well-designed and accounts for most common biases.

Category 3 - The study has important study design limitations.

Category 4 - The study or source is not useful as primary evidence. The article may not be a clinical study, the study design is invalid, or conclusions are based on expert consensus.

The study does not meet the criteria for or is not a hypothesis-based clinical study (e.g., a book chapter or case report or case series description);

Or

The study may synthesize and draw conclusions about several studies such as a literature review article or book chapter but is not primary evidence;

Or

The study is an expert opinion or consensus document.

Category M - Meta-analysis studies are not rated for study quality using the study element method because the method is designed to evaluate individual studies only. An "M" for the study quality will indicate that the study quality has not been evaluated for the meta-analysis study.

Methods Used to Analyze the Evidence

Review of Published Meta-Analyses

Systematic Review with Evidence Tables

Description of the Methods Used to Analyze the Evidence

The topic author assesses the literature then drafts or revises the narrative summarizing the evidence found in the literature. American College of Radiology (ACR) staff drafts an evidence table based on the analysis of the selected literature. These tables rate the study quality for each article included in the narrative.

The expert panel reviews the narrative, evidence table and the supporting literature for each of the topic-variant combinations and assigns an appropriateness rating for each procedure listed in the variant table(s). Each individual panel member assigns a rating based on his/her interpretation of the available evidence.

More information about the evidence table development process can be found in the ACR Appropriateness Criteria® Evidence Table Development document (see the "Availability of Companion Documents" field).

Methods Used to Formulate the Recommendations

Expert Consensus (Delphi)

Description of Methods Used to Formulate the Recommendations

Rating Appropriateness

The American College of Radiology (ACR) Appropriateness Criteria (AC) methodology is based on the RAND/UCLA Appropriateness Method. The appropriateness ratings for each of the procedures or treatments included in the AC topics are determined using a modified Delphi method. An initial survey is conducted to elicit each panelist's expert interpretation of the evidence, based on the available data, regarding the

appropriateness of an imaging or therapeutic procedure for a specific clinical scenario. The expert panel members review the evidence presented and assess the risks or harms of doing the procedure balanced with the benefits of performing the procedure. The direct or indirect costs of a procedure are not considered as a risk or harm when determining appropriateness (additional assumptions regarding rating appropriateness can be found in the document Rating Round Information). When the evidence for a specific topic and variant is uncertain or incomplete, expert opinion may supplement the available evidence or may be the sole source for assessing the appropriateness.

The appropriateness is represented on an ordinal scale that uses integers from 1 to 9 grouped into three categories: 1, 2, or 3 are in the category "usually not appropriate" where the harms of doing the procedure outweigh the benefits; and 7, 8, or 9 are in the category "usually appropriate" where the benefits of doing a procedure outweigh the harms or risks. The middle category, designated "may be appropriate," is represented by 4, 5, or 6 on the scale. The middle category is when the risks and benefits are equivocal or unclear, the dispersion of the individual ratings from the group median rating is too large (i.e., disagreement), the evidence is contradictory or unclear, or there are special circumstances or subpopulations which could influence the risks or benefits that are embedded in the variant.

The ratings assigned by each panel member are presented in a table displaying the frequency distribution of the ratings without identifying which members provided any particular rating. To determine the panel's recommendation, the rating category that contains the median group rating without disagreement is selected. This may be determined after either the first or second rating round. If there is disagreement after the first rating round, a conference call is scheduled to discuss the evidence and, if needed, clarify the variant or procedure description. If there is still disagreement after the second rating round, the recommendation is "may be appropriate."

This modified Delphi method enables each panelist to articulate his or her individual interpretations of the evidence or expert opinion without excessive influence from fellow panelists in a simple, standardized, and economical process. For additional information on the ratings process see the Rating Round Information document.

Additional methodology documents, including a more detailed explanation of the complete topic development process and all ACR AC topics can be found on the ACR Web site (see also the "Availability of Companion Documents" field).

Rating Scheme for the Strength of the Recommendations

Not applicable

Cost Analysis

The guideline developers reviewed a published cost analysis.

Method of Guideline Validation

Internal Peer Review

Description of Method of Guideline Validation

Criteria developed by the Expert Panels are reviewed by the American College of Radiology (ACR) Committee on Appropriateness Criteria (AC).

Evidence Supporting the Recommendations

Type of Evidence Supporting the Recommendations

The recommendations are based on analysis of the current medical evidence literature and the application of the RAND/UCLA appropriateness method and expert panel consensus.

Summary of Evidence

Of the 168 references cited in the *ACR Appropriateness Criteria® Imaging after Total Hip Arthroplasty* document, 166 are categorized as diagnostic references including 4 well designed studies, 16 good quality studies, and 43 quality studies that may have design limitations. Additionally, 1 reference is categorized as a well-designed therapeutic study. There are 103 references that may not be useful as primary evidence. There is 1 reference that is a meta-analysis study.

While there are references that report on studies with design limitations, 21 well designed or good quality studies provide good evidence.

Benefits/Harms of Implementing the Guideline Recommendations

Potential Benefits

Patients with loosening or infection usually (but not always) have pain, whereas those with particle disease and resulting osteolysis or with metal hypersensitivity can be asymptomatic. Pain patterns can suggest the correct diagnosis, but complications can be difficult to identify clinically. Therefore, understanding the use of imaging is of particular importance.

Potential Harms

- The addition of marrow imaging to white blood cell (WBC) scanning has improved accuracy (primarily by decreasing false-positive results) to about 90%, but false-negative cases (decreased sensitivity) can occur.
- False-negative and false-positive results

Relative Radiation Level

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, both because of organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared to those specified for adults. Additional information regarding radiation dose assessment for imaging examinations can be found in the American College of Radiology (ACR) Appropriateness Criteria® Radiation Dose Assessment Introduction document (see "Availability of Companion Documents" field).

Qualifying Statements

Qualifying Statements

- The American College of Radiology (ACR) Committee on Appropriateness Criteria (AC) and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists, and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the U.S. Food and Drug Administration (FDA) have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.
- ACR seeks and encourages collaboration with other organizations on the development of the ACR AC through society representation on expert panels. Participation by representatives from collaborating societies on the expert panel does not necessarily imply individual or society endorsement of the final document.

Implementation of the Guideline

Description of Implementation Strategy

An implementation strategy was not provided.

Institute of Medicine (IOM) National Healthcare Quality Report Categories

IOM Care Need

Getting Better

Staying Healthy

IOM Domain

Effectiveness

Identifying Information and Availability

Bibliographic Source(s)

Weissman BN, Palestro CJ, Appel M, Baccei SJ, Bencardino JT, Fries IB, Hochman MG, Jacobson JA, Mintz DN, Mlady GW, Murphey MD, Newman JS, Rosenberg ZS, Rubin DA, Small KM, Expert Panel on Musculoskeletal Imaging. ACR Appropriateness CriteriaÂ® imaging after total hip arthroplasty. Reston (VA): American College of Radiology (ACR); 2015. 24 p. [168 references]

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Date Released

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Guideline Developer(s)

American College of Radiology - Medical Specialty Society

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Guideline Committee

Committee on Appropriateness Criteria, Expert Panel on Musculoskeletal Imaging

Composition of Group That Authored the Guideline

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Financial Disclosures/Conflicts of Interest

Not stated

Guideline Status

This is the current release of the guideline.

This guideline updates a previous version: Weissman BN, Dalinka MK, Alazraki N, Daffner RH, DeSmet AA, El-Khoury GY, Kneeland JB, Manaster BJ, Pavlov H, Rubin DA, Steinbach LS, Haralson RH III, Expert Panel on Musculoskeletal Imaging. Imaging after total hip arthroplasty (THA). [online publication]. Reston (VA): American College of Radiology (ACR); 2005. 8 p. [51 references]

This guideline meets NGC's 2013 (revised) inclusion criteria.

Guideline Availability

Available from the American College of Radiology (ACR) Web site .

Availability of Companion Documents

The following are available:

- ACR Appropriateness Criteria®. Overview. Reston (VA): American College of Radiology; 2015 Oct. 3 p. Available from the American College of Radiology (ACR) Web site .
- ACR Appropriateness Criteria®. Literature search process. Reston (VA): American College of Radiology; 2015 Feb. 1 p. Available from the ACR Web site .
- ACR Appropriateness Criteria®. Evidence table development. Reston (VA): American College of Radiology; 2015 Nov. 5 p. Available from the ACR Web site .
- ACR Appropriateness Criteria®. Topic development process. Reston (VA): American College of Radiology; 2015 Nov. 2 p. Available from the ACR Web site .
- ACR Appropriateness Criteria®. Rating round information. Reston (VA): American College of Radiology; 2015 Apr. 5 p. Available from the ACR Web site .
- ACR Appropriateness Criteria®. Radiation dose assessment introduction. Reston (VA): American College of Radiology; 2015 Sep. 3 p. Available from the ACR Web site .
- ACR Appropriateness Criteria®. Manual on contrast media. Reston (VA): American College of Radiology; 2015. 129 p. Available from the ACR Web site .
- ACR Appropriateness Criteria®. Procedure information. Reston (VA): American College of Radiology; 2015 Jul. 2 p. Available from the ACR Web site .
- ACR Appropriateness Criteria® imaging after total hip arthroplasty. Evidence table. Reston (VA): American College of Radiology; 2015. 51 p. Available from the ACR Web site .
- ACR Appropriateness Criteria® imaging after total hip arthroplasty. Literature search. Reston (VA): American College of Radiology; 2015. 2 p. Available from the ACR Web site .

Patient Resources

None available

NGC Status

This NGC summary was completed by ECRI on February 10, 2006. This summary was updated by ECRI Institute on May 17, 2007 following the U.S. Food and Drug Administration (FDA) advisory on Gadolinium-based contrast agents. This summary was updated by ECRI Institute on June 20, 2007 following the U.S. Food and Drug Administration (FDA) advisory on gadolinium-based contrast agents. This summary was updated by ECRI Institute on January 22, 2016.

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